

Auditory Dysfunction: Hearing Loss

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Definition

Hearing loss is decreased perception of loudness and/or diminished speech intelligibility. The quantitative unit of loudness is the decibel. Normal hearing threshold is 0 to 10 decibels. Hearing loss may affect sound perception (pure tone loss) or understanding of speech (discrimination loss). Patients may seek medical help for louder perception but usually need help with speech discrimination. Hearing loss may occur from an abnormality anywhere from the pinna to the auditory cortex. Through proper history and examination, the physician must determine where the abnormality is and recommend proper treatment.

Technique

Table 120.1 lists the causes of hearing impairment. With questioning to determine whether the hearing loss seems unilateral or bilateral, try to have the patient distinguish between loss of loudness acuity and loss of speech intelligibility. In the former category, it is difficult to hear; in the latter, difficult to understand. Of additional importance is whether the hearing loss is stable, progressive, or fluctuating and when the patient thinks the symptom began. A detailed review for family history of deafness, childhood ear disease, head trauma, infection, otologic drugs, noise exposure, or surgery must be carried out.

Awareness of sound is a function of how critical one's hearing requirements may be and how carefully the listener concentrates. A loss exceeding 30 to 40 decibels (dB) for the speech frequencies (300 to 3000 Hz) is unacceptable for conversational communication. Unilateral hearing loss, however, even when total, does not interfere with normal face-to-face communication, even though competing noise and sound localization are more of a problem.

Hearing loss can be categorized as either conductive or sensorineural. The next section defines each term. Discrimination is generally unimpaired with a conductive hearing loss. A patient with such a loss will note sound to be dimmed. Yet, when it is sufficiently amplified, it is clear and intelligible. Such impairment causes the patient to seem to hear better in a noisy environment. This is because the patient's loss attenuates the background noise that would otherwise interfere or mask the speech he or she wishes to hear. The opposite is true of the neurally impaired patient. In this instance environmental noise interferes even more than normal with speech perception. Under ideal listening conditions, that is, in a quiet environment, the functional disability of a sensorineural hearing loss relates to the frequencies involved and the quantity for each frequency.

Basic Science

Hearing function is conveniently considered as occurring in two phases. Phase 1 is the conductive phase and involves

the collection and passage of mechanical vibratory sound energy from the gaseous medium of the environment to the fluid medium of the inner ear. Since energy is largely reflected at the interface of air and water, an efficient impedance matching system with a mechanical advantage of 23:1 serves to prevent this energy loss. This system comprises the ear canal and the eardrum and its attached os-

Table 120.1
Etiology of Hearing Loss

Conductive
External canal obstruction: cerumen, foreign body, discharge, tumor, polyp, atresia
Perforated eardrum: infection, trauma, cholesteatoma
Intact but limited eardrum motion: middle ear fluid exudate, fibrosis, and adhesions
Fixation or disruption of ossicles
Fibrosis: tympanosclerosis, adhesions
Atrophy and necrosis
Bone proliferation: otosclerosis, postinflammatory osteoplasia
Congenital
Neoplasm
Sensorineural
Congenital: lesion and hearing loss bilateral and symmetrical
Endogenous: inherited defect, positive family history
Exogenous: damage during intrauterine life or during birth process; anoxia, rubella, Rh incompatibility
Toxic
Febrile: e.g., measles, flu, pneumonia
Drugs: dihydrostreptomycin, kanamycin, gentamicin, tobramycin
Degeneration: hair cells, supporting cells, ganglion cells
Vascular insufficiency: loss either symmetrical or asymmetrical, either progressive or more stable
Aging: loss symmetrical, usually progressive,
Hereditary: loss symmetrical and progressive, early or late
Insults: generally unilateral but can be bilateral: loss asymmetrical and if pathology controlled, stable
Infection
Cochlear: viral (most common cause of sudden hearing loss), bacteria, syphilis (congenital and acquired)
Retrocochlear: meningitis
Trauma: fractures, concussive
Acute vascular insufficiency
Tumor: temporal bone and cerebellopontine angle: loss generally unilateral and progressive—acoustic neuroma, metastatic tumor
Endolymphatic hydrops: loss unilateral in 80% and bilateral in 20%, usually asymmetrical and fluctuating—Ménière's disease, fluctuating hearing loss
Metabolic disorders: loss both unilateral and bilateral—collagen disease, vasculitis, hyperlipidemia, blood sugar alterations
Noise-induced loss: bilateral, symmetrical, (usually) progressive—acoustic trauma, concussive
Functional hearing loss: loss unilateral, bilateral, asymmetrical—psychogenic, malingering
Central nervous system: loss fluctuating and/or progressive—multiple sclerosis, other neuropathies, tumor, vascular insufficiency

sicles. Sound curves of large amplitude and low intensity as they strike the drum must be converted by the transformer mechanism of the middle ear to waves of small amplitude and low intensity as they reach the footplate of the stapes. This energy is then transformed into fluid-bone energy in the perilymph. Traveling waves in the perilymph move the organ of Corti on the basilar membrane of the scala media (see illustrated reference in Myers et al., 1970).

The sound phase is the sensorineural phase. It begins in the cochlea where the hair cells of the Corti organ transduce vibratory energy into electric potentials. The coding of loudness and pitch occurs here. This information is transmitted via the auditory nerve and brainstem through several intervening nuclear synapses to the auditory cortex for decoding and understanding. Disease or damage in the sensorineural system reduces loudness and distorts sound quality. Thus, in summary, hearing loss is labeled *conductive* when disease affects phase 1 structures and *sensorineural* when it affects phase 2 structures.

Sensorineural loss is further divided into cochlear and retrocochlear categories. Special audiometric and otologic tests enable one to differentiate cochlear and retrocochlear lesions. Such differentiation is sophisticated and requires especially skilled personnel to accomplish it. However, accurate diagnosis requires it to be done when the locus and etiology of a loss are not otherwise clear. For one thing, the etiology and complications of retrocochlear disease tend to be more threatening to the patient's welfare. In the adult, sensorineural loss is statistically much more common than conductive loss. The reverse is true for children and adults to age 40. For the neurally impaired, cochlear is several times more common than retrocochlear loss.

The audible sound spectrum ranges from 16 to 16,000 hertz (Hz). The majority of human speech sounds are bracketed by the frequencies 300 to 3000 Hz. Loss of acuity above 3000 Hz, often the only deficit seen in early sensorineural lesions, will generally affect discrimination of clarity of sound. This impairment is noted more in a noisy environment.

Loudness is measured in decibels. One decibel equals 2×10^{-4} dynes per square centimeter (2×10^{-4} dyn/cm²). A loudness scale is logarithmic. For example, a 20-dB tone has 100 times more energy than a 1-dB tone. Thresholds need to be determined by audiometry, but tuning-fork tests should be used on all patients to indicate conductive or sensorineural loss. These tests are described in Chapter 126. Loudness threshold is the least intense sound perceived by the individual, or, stated differently, the weakest sound audible to the patient. Standard normal threshold was derived by testing thousands of people. This normal is arbitrarily considered 0 dB (Kornblut, 1985).

Clinical Significance

We all talk to hear ourselves. The voice is monitored by the ear; thus, totally deaf patients make distorted speech sounds

because they cannot monitor their own voice properly. Deaf children do not usually develop normal speech (prelingual). Adults who are deafened after learning to speak (postlingual) can modulate the voice better because of years of conditioning.

Hearing levels greater than 25 dB in a child may significantly impair learning and the development of normal living patterns. Adequate communication skills are needed in all occupations. Patients presenting with hearing loss must have their loss accurately delineated by proper history, clinical examination, audiometry, and specialized radiologic, metabolic, or immunologic tests.

Accurate diagnosis will permit proper treatment of infection, impacted cerumen, or associated allergy, or the arrest of progressive disease such as cholesteatoma or acoustic neuroma. Virtually all hearing loss can be helped. Once it is categorized as either conductive or sensorineural, surgery, medical treatment, or hearing amplification may restore useful hearing. Even total sensory (inner ear) deafness can now be helped with a cochlear implant. Hearing aids are being produced that can be specifically adapted to the individual patient's hearing loss. Dramatic, permanent hearing improvement has been made available to tens of thousands of patients with otosclerosis in the past 25 years through stapedectomy surgery.

All physicians evaluating patients with hearing loss must learn proper techniques of ear examination including adequate removal of wax and canal debris to permit accurate diagnosis. Standard tuning-fork tests, conducted properly, will accurately categorize conductive or sensorineural loss.

Hearing loss is often present with other clinical symptoms, such as vertigo, headache, tinnitus, blurred vision, or facial paralysis. Proper investigation of the ear and hearing acuity will often help to classify the symptoms into a specific disease category.

Hearing loss progresses rapidly in most patients over the age of 75 years. As the population continues to grow older, physicians will have larger numbers of geriatric patients with hearing symptoms. Increased awareness and use of skillful examination techniques will become increasingly important to all primary practitioners caring for the elderly.

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